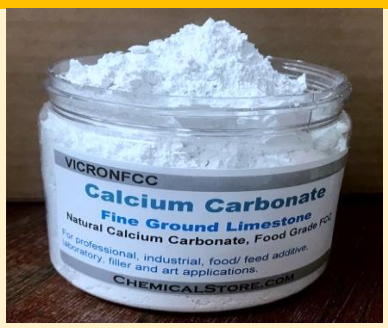
CHAPTER 11: SALTS

SODIUM CHLORIDE	CALCIUM CARBONATE	COPPER (II) SULPHATE
		

Key words	Learning Outcomes (LOs)
Salt Normal and acid salts Neutralization reactions	By the end of this chapter, you should be able to a) Be familiar with and be able to carry out neutralization reactions to prepare salts. b) Know and appreciate the uses of common salts in everyday life.

COMPETENCY: The learner **appreciates** that acids and alkalis form salts

11.1. Introduction.

In this section, you will appreciate the acids and bases as the back – bone in salt preparations. The methods used when preparing salts. The uses of various salts. The type of salts formed when bases react with acids. The solubility of salts in water

11.2. SALTS

Salt is a compound formed when part or all the ionizable hydrogen ions of the acid is replaced by a metallic ions or ammonium ions. Salt is a product of reacting a base with an acid.

a) Normal salts: This is a type of salt formed when all the ionizable hydrogen ions of the acid are replaced by a metallic ion.

Examples of normal salts:

Normal salt	Examples
⊔ Sulphates	Sodium sulphate, zinc sulphate, copper (II) sulphate
⊔ Chlorides	Sodium chloride, zinc chloride, calcium chloride etc.
⊔ Carbonates	Sodium carbonate, calcium carbonate, copper (II) carbonate

⌴ Nitrates	Sodium nitrate, lead (II) nitrate, potassium nitrate, zinc nitrate
⌴ Phosphates	Calcium phosphate, sodium phosphate

.**b) Acid salts:** This a type of salt formed when part of the ionizable hydrogen ions of the acid are replaced by a metallic ion or ammonium ions.

Acid salt	**Examples**
⌴ Hydrogen Sulphates	Sodium hydrogen sulphate, potassium hydrogen sulphate
⌴ Hydrogen carbonates	Sodium hydrogen carbonate, potassium hydrogen carbonate, magnesium hydrogen carbonate
⌴ Hydrogen phosphates	Sodium hydrogen phosphate

Discussion Question: 11.2(a)

In groups, discuss how to write the possible names of normal and acid salts of sodium and lead. Share and compare your findings with the rest of the class. Use the table below.

Name of acid	**Hydrochloric acid**	**Nitric acid**	**Sulphuric acid**	**Phosphoric acid**	**Carbonic acid**
Normal salt of sodium	Sodium chloride	Sodium nitrate	Sodium sulphate	Sodium phosphate	Sodium carbonate
Acid salt of sodium	None	None	Sodium hydrogen sulphate	Sodium dihydrogen phosphate	Sodium hydrogen carbonate

11.3. PREPARATION OF SALTS

Salts are normally prepared basing on their degree of solubility in water. Salts that dissolve readily in water, form salt solution called **soluble salts** while those salts that are insoluble in water, form **insoluble salts**.

Salts	**Rules**
⌴ Nitrates	**All** salts of nitrates are very soluble in water
⌴ Chlorides	**All** salts of chlorides are soluble in water **except** silver chloride and lead (II) chloride.
⌴ Sulphates	**All** salts of Sulphates are soluble in water **except** barium sulphate and lead (II) sulphate.

Carbonates	**All** salts of carbonates are insoluble in water **except** sodium carbonate, potassium carbonate and ammonium carbonate.

Examples

Salts	Examples
Nitrates	**Barium** nitrate, **Aluminium** nitrate, **zinc** nitrate, **iron** (II) nitrate, **copper** (II) nitrate, **calcium** nitrate, **ammonium** nitrate, **lead** (II) nitrate
Chlorides	**Sodium** chloride, **lead** (II) chloride, **calcium** chloride, **Copper** (II) chloride, **silver** chloride, **ammonium** chloride.
Sulphates	**Barium** sulphate, **copper** (II) sulphate, **lead** (II) sulphate, **sodium** sulphate, **magnesium** sulphate, **zinc** sulphate, **Aluminium** sulphate.
Carbonates	**Calcium** carbonate, **sodium** carbonate, **zinc** carbonate, **potassium** carbonate, **copper** (II) carbonate, **magnesium** carbonate, **ammonium** carbonate.

ACTIVITY:11.2(b)

What you need:

Sodium carbonate, calcium carbonate, lead (II) nitrate, ammonium chloride, copper (II) sulphate, lead (II) sulphate, water, boiling tubes and racks.

What you need:

In groups, carry out the following activities to find out the solubility of some salts in water.

Treat your experiments as follow:

Experiment	Activity
A	To one spatula endful of sodium carbonate in a clean boiling tube, add about 6 cm^3 of distilled water, shake well to dissolve. Make your observation
B	Repeat the procedure in Experiment A using lead (II) nitrate. Make your observation
C	Repeat the procedure in Experiment A using calcium carbonate. Make your observation
D	Repeat the procedure in Experiment A using ammonium chloride. Make your observation

E	Repeat the procedure in Experiment A using copper (II) sulphate. Make your observation
F	Repeat the procedure in Experiment A using lead (II) sulphate. Make your observation.

Observations: Table of results.

Experiment	Salt	Soluble salt	Insoluble salt
A	Sodium carbonate	√	**x**
B	Lead (II) nitrate	√	**x**
C	Calcium carbonate	**x**	√
D	Ammonium chloride	√	**x**
E	Copper (II) sulphate	√	**x**
F	Lead (II) sulphate	**x**	√

11.3. Methods of preparing Soluble salts

a) Neutralization reaction of an acid on an alkalis

ACTIVITY:11.3(a)

What you need:

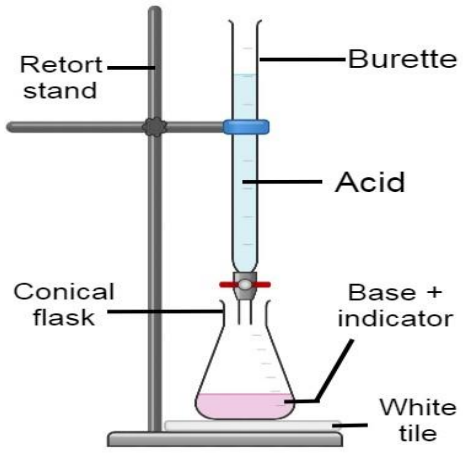
Burette with tap, 50mls measuring cylinder, conical flasks, dropping funnel, stand and a clamp, evaporating dish, heat source, 2M hydrochloric acid, phenolphthalein indicator, 2M sodium hydroxide solution.

What to do:

In groups, carry out the following activities, to prepare sodium chloride salt from the action of hydrochloric acid on sodium hydroxide solution.

1. Measure 25cm^3 of sodium hydroxide solution into a clean conical flask. Add 3 drops of phenolphthalein indicator. Place the flask on a while tile.

2. Fill the burette with dilute hydrochloric acid. Ensure the apparatus is firmly held on a stand and a clamp. Note the starting volume of the acid.



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3.Run down the burette content into the content of the conical flask, drop by drop until the pink	

colour of the conical flask turns colourless. End the titration, and note the final volume of the burette. Ensure you shake the contents of the flask carefully to allow uniform mixing of the solution mixture.

Evaporation to dryness:

4.Transfer the resultant solution mixture which contains sodium chloride solution and water into an evaporating dish, and heat to evaporate off water until it is concentrated.

5.Pour the concentrated solution into a clean beaker and allow it to cool and crystallize out sodium chloride.

6.Wash the crystals formed with little distilled water and then allow them dry between filter paper.

Word Equation

Sodium Hydroxide + Hydrochloric acid $\longrightarrow$ Sodium chloride + Water

$NaOH\ (aq) + HCl\ (aq) \longrightarrow NaCl\ (aq) + H_2O\ (l)$

b) Neutralization reaction of an acid on basic oxides

ACTIVITY:11.3(b) Preparation of Magnesium sulphate

What you need

Magnesium oxide, dilute Sulphuric acid, Bunsen burner, beaker, filter papers and a funnel, evaporating dish, thermometer, tripod stand with wire gauze, measuring cylinder and glass rod.

Caution! Warm the acid with extra care since it fumes when heated and it is corrosive to surface objects**.**

What to do:

In groups, carryout the following steps to help you prepare dry magnesium sulphate crystals from magnesium oxide. Use the following steps below:

1) Using a measuring cylinder, obtain 50cm^3 of dilute Sulphuric acid into a clean glass beaker.
2) Insert a thermometer into a beaker of dilute Sulphuric acid, place it on a tripod stand and heat the acid gently until a temperature of 60^{o}C is reached.
3) Add magnesium oxide little by little into a warm dilute acid while stirring with a glass rod until the oxide is in excess to form a white suspension.

4) Filter the mixture to obtain the excess unreacted magnesium oxides as residue and magnesium sulphate as filtrate.
5) Transfer the resultant solution mixture which contains magnesium sulphate solution and water into an evaporating dish, and heat to evaporate off water until it is concentrated.
6) Pour the concentrated solution into a clean beaker and allow it to cool and crystallize out.
7) Wash the crystals formed with little distilled water and then allow them dry between filter paper.
8) Transfer the filtrate into an evaporating dish. Gently heat the filtrate to evaporate off excess water and to form a saturated solution.
9) Continue heating the saturated solution until crystals start forming out, decant or filter to remove the crystals, dry the crystals between filter paper or under the sun.

Word Equation

Magnesium Oxide + Sulphuric acid ⟶ Magnesium sulphate + Water

$MgO(s) + H_2SO_4(aq) \longrightarrow MgSO_4(aq) + H_2O(l)$

Discussion Question: 11.2(c)

In groups

a) Suggest the names of the compounds when the following metal oxides react with acids. Share and compare your findings with the rest of the class. use the table

Name of acid	Name of metal oxide	Name of salt formed
Hydrochloric acid	Copper (II) Oxide	Copper (II) Chloride
Sulphuric acid	**Copper (II) Oxide**	Copper (II) sulphate
Sulphuric acid	Zinc oxide	**Zinc sulphate**
Nitric acid	Calcium Oxide	**Calcium nitrate**
Nitric acid	Lead (II) Oxide	Lead (II) nitrate

b) Write word equations for the reactions that took place between the acids and basic oxides

11.3(a). Preparation of insoluble salts: By double decomposition (Precipitation) method

Precipitation (Double decomposition)

This refers to the reaction between two soluble salts resulting in the formation of an insoluble salt as a precipitate and the other as solution

ACTIVITY:11.3(a) Preparation of Lead (II) sulphate:

What you need

Filter paper, funnel, dilute Sulphuric acid, lead (II) nitrate solution, beaker, distilled water.

What to do

In groups, carry out the following activity, to find out how Lead (II) sulphate is prepared using dilute Sulphuric acid, and lead (II) nitrate solution.

1.Put 25mls of lead (II) nitrate solution into a glass beaker, then add dilute Sulphuric acid drop by drop until in excess, ensure stirring at all time.

2. Filter off the precipitate, using a filter funnel, and discard the filtrate obtained.

3. Wash the precipitate obtained for 2 to 3 more times with warm distilled water to remove any acid that remained.

4. Dry the precipitate either in a steam oven or by leaving it to dry in the air.

Word Equation

Lead (II) nitrate + Sulphuric acid ⟶ Lead (II) sulphate + Nitric acid

$Pb(NO_3)_2(aq) + H_2SO_4(aq) \longrightarrow PbSO_4(s) + 2HNO_3(aq)$.

Other forms of insoluble salts and their preparation

Two soluble salts		Solid residue	Filtrate
Sodium sulphate	Barium nitrate	**Barium sulphate**	**Sodium nitrate**
Sodium carbonate	Zinc sulphate	Zinc carbonate	Sodium sulphate
Silver nitrate	Sodium chloride	Silver nitrate	Sodium nitrate
Sodium carbonate	Copper (II) nitrate	Copper (II) carbonate	Sodium nitrate

a) Write word equations for the reactions that took place between the two salts in (b)

ACTIVITY11.3(b) Preparation of copper (II) sulphate crystals

What you need

Copper (II) carbonate, dilute Sulphuric acid, glass beaker, filter paper and funnel, stirring glass rod, heat source, evaporating dish and thermometer.

What to do

In groups, conduct the following activity to prepare hydrated salts of copper (II) sulphate crystals starting from copper (II) carbonate and Sulphuric acid.

1) **Fill the glass beaker with 50mls of dilute Sulphuric acid and warm the acid until a temperature of 60°C on a Bunsen burner flame.**

2) Add solid copper (II) carbonate little by little to the warm dilute Sulphuric acid, while stirring until copper (II) carbonate is in excess. Make observation.
3) Filter the mixture to obtain the filtrate and solid residue, in a clean beaker.
4) **T**ransfer the resultant solution mixture which contains copper (II) sulphate solution and water into an evaporating dish, and heat to evaporate off water until it is concentrated**.**
5) Pour the concentrated solution into a clean beaker and allow it to cool and crystallize out.
6) Wash the crystals formed with little distilled water and then allow them dry between filter paper.
7) Transfer the filtrate into an evaporating dish. Gently heat the filtrate to evaporate off excess water and to form a saturated solution.
8) Continue heating the saturated solution until crystals start forming out, decant or filter to remove the crystals, dry the crystals between filter paper or under the sun.

Word Equation

Sulphuric + Copper (II) ⟶ Copper (II) + Water + Carbon dioxide.
acid carbonate sulphate

$H_2SO_4(aq) + CuCO_3(s) \longrightarrow CuSO_4(aq) + H_2O(l) + CO_2(g)$

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11.4. Uses of the common salts

1) Some salts such as magnesium hydroxide, sodium bicarbonate act as antacids used by man to reduce the acidic pH levels in the stomach that causes heart burns, inflammation and indigestion of food.

2) Some salts such as sodium chloride are used as food flavour, giving food salty taste. It is also used in the preservation and drying of fish.

3) Salts such as calcium sulphate, contains components of plaster of Paris used in hospitals to immobilize broken bone of humans.

4) Some salts are used as lime to correct the soil and water pH levels example include calcium carbonate.

5) Some salts are used as basic or acidic fertilizers to correct the pH of soil example include ammonium nitrate or ammonium sulphate.

11.5. Chemical formulae of salts, acids and bases.

a) Valency: refers to the number of electrons an atom gains or losses to form chemical bonds with other atoms. It is also referred to as the combining power of an element or a radical.

b) Radicals: refer to an atom or group of atoms that cannot exist on their own but in combined formed with metals or ammonium ions.

Table 1 showing the Valency of metals after losing their electrons

Metal	Symbol	Valency
Sodium	*Na*	1
Potassium	*K*	
Hydrogen	*H*	
Silver	*Ag*	
Ammonium	NH_4	
Magnesium	*Mg*	2
Calcium	*Ca*	
Copper (II)	*Cu*	
Lead (II)	*Pb*	
Zinc	*Zn*	2
Iron (II)	*Fe*	
Aluminium	*Al*	3
Iron (III)	*Fe*	

Table 2 showing the Valency of radicals

Radical	Formula	Valency
Chloride	*Cl*	1
Nitrate	NO_3	
Hydroxide	*OH*	
Hydrogen carbonate	HCO_3	
Hydrogen sulphate	HSO_4	
Sulphate	SO_4	2
Carbonate	CO_3	
Oxide	*O*	
Sulphite	SO_3	
Phosphate	PO_4	3
Carbide	*C*	4
Silicide	*Si*	

Rules to follow when writing chemical formulae of a compounds.

1. Write the correct symbols / formulae of the substances that are involved.
2. Write the valences of the species in its top – most right-hand corner.

3. Cross multiple the valence of each species and place them at the bottom – most right – hand corner of the compound formed.

Worked out Examples.

Formation of Sulphuric acid, H_2SO_4	Formation of potassium carbonate, K_2CO_3
Species: Hydrogen Sulphate **Step1:** H SO_4 **Step2:** H^1 SO_4^2 **Step3:** H_2SO_4	Species: Potassium Carbonate Step1: K CO_3 Step2: K^1 CO_3^2 Step3: K_2CO_3
Formation of calcium chloride, $CaCl_2$	Formation of calcium carbonate, $CaCO_3$
Species: **Calcium Chloride** **Step1:** Ca Cl **Step2:** Ca^2 Cl^1 **Step3:** $CaCl_2$	Species: Calcium Carbonate Step1: Ca CO_3 Step2: Ca^2 CO_3^2 Step3: $CaCO_3$
Formation of Aluminium sulphate, $Al_2(SO_4)_3$	Formation of ammonium sulphate, $(NH_4)_2SO_4$
Species: Aluminium Sulphate Step1: Al SO_4 Step2: Al^3 (SO_4^2) Step3: $Al_2(SO_4)_3$	Species: Ammonium Sulphate Step1: NH_4 SO_4 Step2: (NH_4^1) SO_4^2 Step3: $(NH_4)_2SO_4$

Discussion Question: 11.5(a)

a)Writing the chemical formulae of compounds

In groups, write to show how the chemical formulae of compounds are formed. Share and compare your findings with the rest of the members in your class. Use the questions below.

b) Show how each of the following compounds is expressed in terms of chemical formulae.

i) Sodium sulphate, Na_2SO_4, Sodium Chloride, $NaCl$ and sodium phosphate, Na_3PO_4

ii) Potassium Hydrogen carbonate, $KHCO_3$, Potassium Iodide, KI

iii) Lead (II) nitrate, $Pb(NO_3)_2$, Lead (II) Chloride, $PbCl_2$, Lead (II) sulphate, $PbSO_4$

iv) Copper (II) Sulphate, ***$CuSO_4$***, Copper (II) Oxide, ***CuO***, Copper (II) carbonate, ***$CuCO_3$***

v) Water, ***H_2O***, Hydrochloric acid, ***HCl***, Nitric acid, ***HNO_3***, Phosphoric acid, ***H_3PO_4***

vi) Iron (II) sulphate, ***$FeSO_4$***, Iron (III) sulphate, ***$Fe_2(SO_4)_3$***, iron (III) oxide, ***Fe_2O_3***

11.7. End of Chapter TWO summary: In this chapter, you have learnt that:

- **Salt** is a substance formed when the hydrogen ions of the acid is completely or partially replaced by a metal or ammonium ions. Salt is either normal or an acid.
- **Normal salt** is a substance formed when the hydrogen ions of the acid are completely replaced by a metal ion.
- **An acid salt** is a substance formed when the hydrogen ion of acid is partially replaced by a metal or ammonium ion.
- **Salt** is either soluble or insoluble in water.
- **Neutralization** reaction is the major method of salt preparations especially for soluble salts. It refers to the reaction which involves interaction between a soluble base and an acid to form salt and water only.
- **Precipitation (Double decomposition)** reaction refers to the reaction between two soluble salts resulting in the formation of an insoluble salt as a precipitate and other a solution.
- Salts are one of the most successful chemicals on Earth and play a variety of uses in human lives, such as softening hard water, pH control, preservation, Food additives, stomach drugs, etc.

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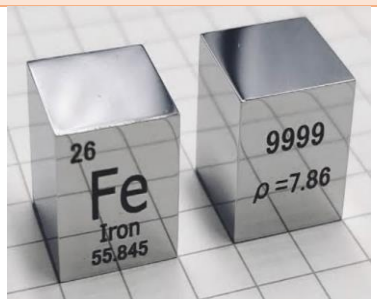
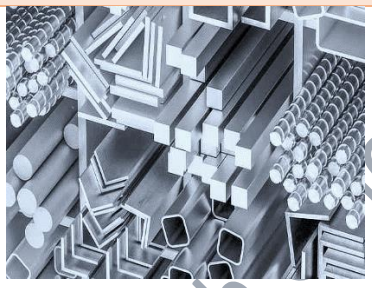
CHAPTER: 12 THE PERIODIC TABLE

Silver metal	Oxygen	Sulphur
		
Iron metal	**Aluminium metal**	**Copper metal**

Key words	Learning outcomes:
▪ Atoms ▪ Elements ▪ Classification of elements. ▪ Fundamental particles of atoms. ▪ Electrons, protons and neutrons. ▪ Structure of an atom and an ion. ▪ Electronic configuration. ▪ Atomic number and atomic mass	By the end of this chapter, you should be able to: a) Understand that elements can be grouped into metals and non – metals and relate the physical properties of metals and non – metals to their uses. b) Know that the Periodic Table is a classification of elements according to their atomic (proton) number. c) Relate the arrangement of electrons in the first 20 elements to their position in the Periodic Table. d) Understand the relationship between the position of elements in groups and change on the ions that they form.

COMPTENCY: The learner investigates the diversity of the elements in the Periodic table

12.1. Elements

An atom: This is the smallest indivisible particle of an element that can take part in the chemical reaction.

An element: This a substance that cannot be divided further into simpler forms by any known chemical means. All elements are made of only one type of their atoms. All elements are represented by **chemical symbols**.

Classification of elements

Elements are classified mainly as **metals** and **non – metals.**

Physical properties of metals and non – metals

Properties	Metals	Non – metals
Ductile	Can be pulled into thin wires	Brittle (easily breaks)
Malleable	Can be molded into desired shaped	Cannot be molded into desired shaped
Sonorous	Makes sound when hit	Makes no sound when hit
Loss or gain of electrons	Lose electrons	Gain electrons
Can conduct heat or electricity	Conduct heat or electricity	Poor conductor of heat or electricity **except** graphite
Density	More dense	Less dense
Hardness	Very hard and strong	Not hard
Melting point	High melting point	Low melting point

Uses of metals and non – metals

Uses	Composition
Used in construction of Aero plane	Aluminium
Used for making cooking utensils	Aluminium
Used as building materials, such as roofing, engine blocks of vehicles, and cutleries	Iron
Used in making electrical wires, pad locks, coins, medals.	Copper
Used in making ceramic materials such as plates, pots, scapulars	Silicon, Aluminium
Used in making glass	Silicon

Used in making earrings, necklaces, lead pencils	Carbon graphite or diamond

12.2. Atomic structure of an atom of an element

John Dalton was one of the famous great Chemist who attributed a lot in the science fields. He developed many laws and theories of which, one of them being the theory about atoms, called the **Dalton's Atomic Theory**.

ATOMIC THEORY: It states that: -

a) All matter is made up of tiny particles called atom.
b) Atoms cannot be created or destroyed but can be transformed from one state to another.
c) Atoms of the same element, are identical and have the same chemical properties and same mass.
d) Atoms' identity differs from one element to another and they combine in simple ratio to form molecules (compounds)

12.3. Fundamental particles of an atom.

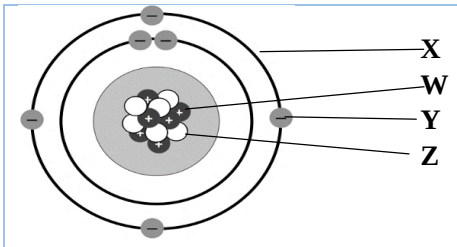
Protons	Neutrons	Electrons
Are positive charged particles Found in the nucleus of an atom. Have relative mass of 1	Are neutral particles Found in the nucleus of an atom. Has relative mass of 1	Are negative charged particles Found around the nucleus of an atom Has relative mass of $\frac{1}{1836}$

Discussion Question 12.3(a):

a) Copy and complete the following sub – atomic particles of an atom using the table below.

Differences	Protons	Neutrons	Electrons
Location.			
Symbol			
Relative charge			
Particle number			

b) Study the diagram below and use it to answer the questions that follow



Identify what the following represent.

X_____

W_____

Y_____

Z _____

c)Draw to show the position of each sub – atomic particle of an atom identified in (b)

12.4. Electronic configuration (E.C) of first 20 elements

Table showing the composition of the protons, electrons and neutron number of first 20 elements

Element	Symbol	(p) No	(e) No	(n) No
Hydrogen	**H**	1	1	**0**
Helium	**He**	2	2	**2**
Lithium	**Li**	3	3	**4**
Beryllium	**be**	4	4	**5**
Boron	**B**	5	5	**6**
Carbon	**C**	6	6	**6**
Nitrogen	**N**	7	7	**7**
Oxygen	**O**	8	8	**8**
Fluorine	**F**	9	9	**10**
Neon	**Ne**	10	10	**10**
Sodium	Na	11	11	**12**
Magnesium	**Mg**	12	12	**12**
Aluminium	**Al**	13	13	**14**
Silicon	**Si**	14	14	**14**
Phosphorous	**P**	15	15	**16**
Sulphur	**S**	16	16	**16**
Chlorine	**Cl**	17	17	**18**
Argon	**Ar**	18	18	**20**
Potassium	**K**	19	19	**20**
Calcium	**Ca**	20	20	**20**

Table showing the electronic configuration (E.C) of first 20 elements

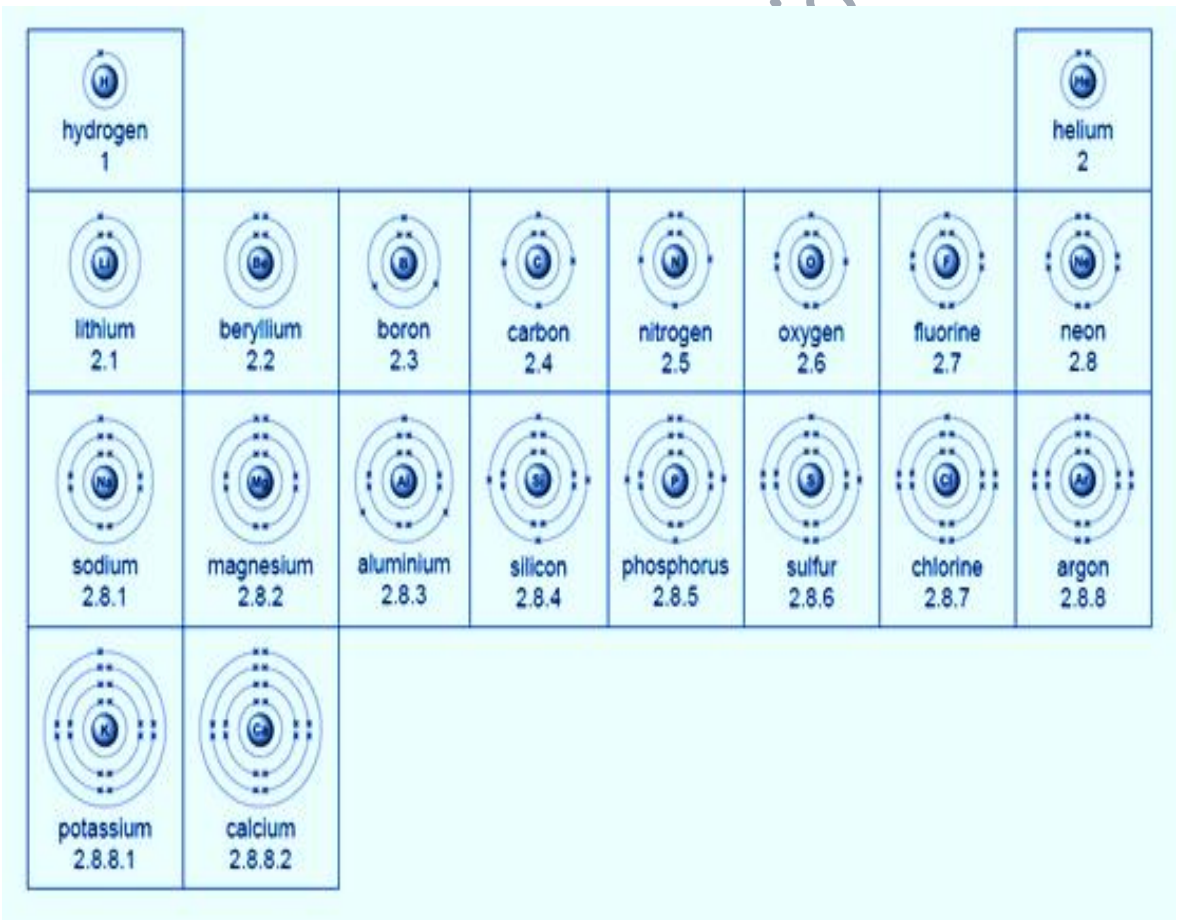
Number	Name	Symbol	E. C
1	Hydrogen	**H**	**1**
2	Helium	**He**	**2**
3	Lithium	**Li**	**2:1**
4	Beryllium	**Be**	**2:2**
5	Boron	**B**	**2:3**
11	**Sodium**	Na	**2:8:1**
12	Magnesium	**Mg**	**2:8:2**
13	Aluminium	**Al**	**2:8:3**
14	Silicon	**Si**	**2:8:4**
15	Phosphorous	**P**	**2:8:5**
16	Sulphur	**S**	**2:8:6**

6	Carbon	**C**	**2:4**	17	Chlorine	**Cl**	**2:8:7**
7	Nitrogen	**N**	**2:5**	18	Argon	**Ar**	**2:8:8**
8	Oxygen	**O**	**2:6**	19	Potassium	**K**	**2:8:8:1**
9	Fluorine	**F**	**2:7**	20	Calcium	**Ca**	**2:8:8:2**
10	Neon	**Ne**	**2:8**				

12.5. Electron arrangement using Energy levels

Energy levels: Refer to the region of higher chance where electrons are arranged around the nucleus.

(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)

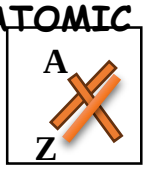


Discussion Question 12.3(b)

In groups, complete the table below by writing the symbols of elements and placing them into periods and groups using the table below.

Group	I	II	III	IV	V	VI	VII	VIII
Period 1	**1.**							**2.**
Period 2	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
Period 3	**11.**	**12.**	**13.**	**14.**	**15.**	**16.**	**17.**	**18.**
Period 4	**19.**	**20.**						

12.4. ATOMIC NUMBER AND ATOMIC MASS



(A)----Atomic mass
(X)---- An element
(Z)--- Atomic Number

ATOMIC NUMBER (Z) is the number of protons in the nucleus of an atom of an element. Proton number (**Z**) varies from one atom of an element to another atom.

It is represented by the symbol **(Z) = (p),** where **p** is the number of protons.

ATOMIC MASS (A) is the sum of **proton** and **neutron** number in the nucleus of an atom. it is also called Mass number or Nucleon number. Mass number may vary from one element to another. It is represented by the symbol, **(A) = (p +n)**

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Copy the table 2.4(a) below correctly in your notebook.

Symbol	Atomic Number (Z)	Atomic mass (A)	Electronic Configuration
$^{1}_{1}H$	1	1	1
$^{4}_{2}He$	2	4	2
$^{7}_{3}Li$	3	7	2:1
$^{9}_{4}Be$	4	9	2:2
$^{11}_{5}B$	5	11	2:3
$^{12}_{6}C$	6	12	2:4
$^{14}_{7}N$	7	14	2:5

$^{16}_{8}O$	8	16	2:6
$^{19}_{9}F$	9	19	2:7
$^{20}_{10}Ne$	10	20	2:8
$^{23}_{11}Na$	11	23	2:8:1
$^{24}_{12}Mg$	12	24	2:8:2
$^{27}_{13}Al$	13	27	2:8:3
$^{28}_{14}Si$	14	28	2:8:4
$^{31}_{15}P$	15	31	2:8:5
$^{32}_{16}S$	16	32	2:8:6
$^{35}_{17}Cl$	17	35	2:8:7
$^{40}_{18}Ar$	18	40	2:8:8
$^{39}_{19}K$	19	49	2:8:8:1
$^{40}_{20}Ca$	20	40	2:8:8:2

12.4. ISOTOPES OF ATOMS OF AN ELEMENT

Isotope Refers to atoms of the same element with the same proton number but different neutron number.

OR Atoms of the same element having the same atomic number but different mass number.:

Element	Atoms	Proton No	Neutron No	Element	Atoms	Atomic No	Mass No
Helium	$^{4}_{2}He$	2	2	Neon	$^{20}_{10}Ne$	10	10
	$^{3}_{2}He$	2	1		$^{21}_{10}Ne$	10	11
Boron	$^{11}_{5}B$	5	6		$^{22}_{10}Ne$	10	12
	$^{10}_{5}B$	5	5	Carbon	$^{12}_{6}C$	6	6
Nitrogen	$^{14}_{7}N$	7	7		$^{13}_{6}C$	6	7
	$^{13}_{7}N$	7	6		$^{14}_{6}C$	6	8
Chlorine	$^{37}_{17}Cl$	17	20	Magnesium	$^{24}_{12}Mg$	12	12

	$^{35}_{17}Cl$	17	18		$^{25}_{12}Mg$	12	13
					$^{26}_{12}Mg$	12	14

Discussion Questions:

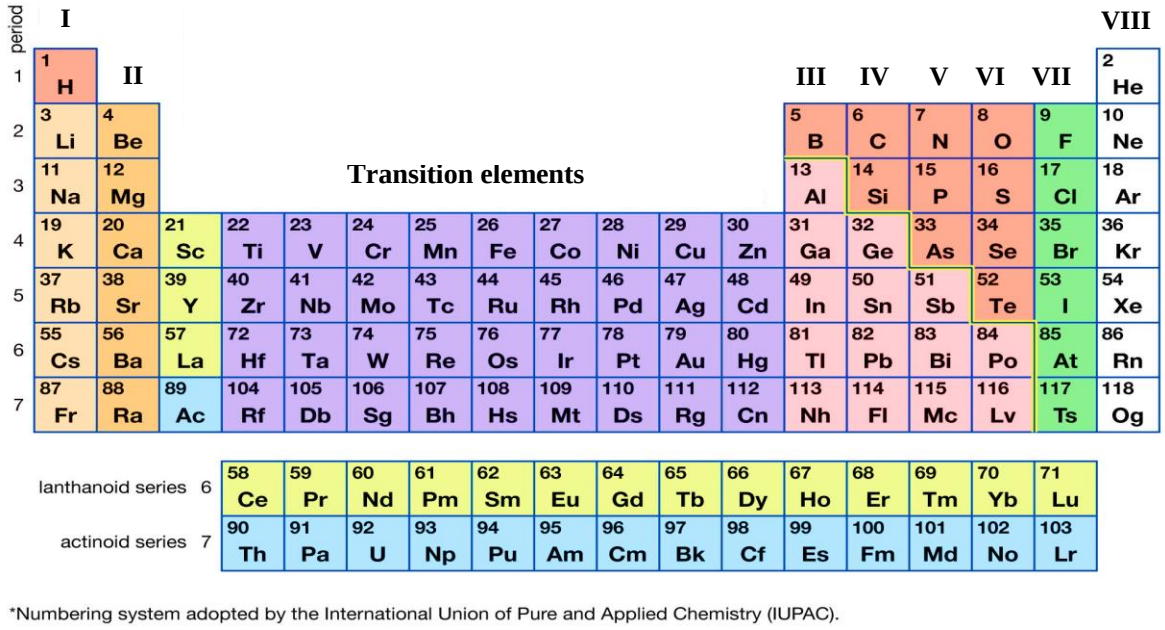
a) What conclusions do you make about:

(i) proton and neutron number of the atoms of the same elements in the first table.

(ii) Atomic and mass number of the atoms of the same elements in the second table.

b) Suggest what is meant by the term "**isotope".**

12.5. PERIODIC TABLE OF ELEMENTS



*Numbering system adopted by the International Union of Pure and Applied Chemistry (IUPAC).

1. **Sir. Dmitri Mendeleev,** a Russian Chemist who was behind the publicity of the original Periodic Table. He was able to assemble the known elements in the order of their increasing atomic masses, followed by their physical and chemical properties in a periodic function. His vertical columns became the groups numbered in romans numerals I, II, III, IV, V, VI, VII and VIII. The horizontal rows became the periods from 1, 2, 3, 4, 5, 6 and 7. He left some gaps in his Periodic table.

12.6. MODERN PERIODIC TABLE

2. **Henrey Moseley:** Was an English physicist who modified Mendeleev's periodic law using X – ray emissions from the elements. He came up with modern periodic law

2. **Modern Periodic Law:** States the physical and chemical properties of elements are the periodic functions of their atomic number.

Characteristics of Modern Periodic Table

(i) Elements in group I, II, III are called **metals** and they are located at the extreme left of the Modern Periodic Table.

(ii) Elements in group IV. V. VI and VII are called **non – metals** and they are located at the extreme right of the Modern Periodic Table.

(iii) Elements in each period have different physical and chemical properties. For instance, elements in period 3 of the Modern Periodic Table.

(iv) Elements that belong to the same group, have the same physical and chemical properties. For instance, group I differ from the next groups in their properties.

(v) Metal elements form **positive** charged ions called **cations** by lose of electrons in their outer – most energy levels.

(vi) Non – metal elements form **negative** charged ions called **anions** by gain of electrons in their outer – most energy levels.

12.7. ION FORMATION

Ions: Are referred to as positive charged or negative charged particles.

Cations: Are positively charged particles. They are formed when metal elements lose electrons.

Anions: Are negatively charged particles. They are formed when non – metal elements gain electrons.

Did you know?

After gaining or losing electrons, all **cations** and **anions** form stable electronic structures after loss or gain of electrons and adopt the stable electron structures of noble gases.

a) Formation of cations from metallic atoms

Atom	Symbol	E. C	Name of ions	Symbol	E.C
Sodium	$_{11}Na$	2:8:1	Sodium ions	$_{10}Na^{+}$	2:8
Magnesium	$_{12}Mg$	2:8:2	Magnesium ions	$_{10}Mg^{2+}$	2:8
Aluminium	$_{13}Al$	2:8:3	Aluminium ions	$_{10}Al^{3+}$	2:8

Discussion Questions 12.8(a)

In groups, discuss how the following cations are formed when the following metals lose their valence electrons. Use the table below.

Metal atom	Symbol	E.C	Name of ions	Symbol	E.C
Aluminium Z =13					
Beryllium, Z = 4					
Potassium, Z =19					
Calcium, Z =20					

b) Formation of anions from non – metal atoms

Non – metal atom	Symbol	E.C	Name of ions	Symbol	E.C
Oxygen,	$_{8}O$	**2:6**	Oxide ions	$_{10}O^{2-}$	**2:8**
Fluorine	$_{9}F$	**2:7**	Fluoride ions	$_{10}F^{-}$	**2:8**

Discussion Question 12.8(b)

In groups, discuss how the following cations are formed when the following metals lose their valence electrons. Use the table below.

Metal atom	Symbol	E.C	Name of ions	Symbol	E.C
Nitrogen Z =7					
Carbon, Z = 6					
Sulphur, Z =16					
Chlorine, Z =17					
Silicon, Z =14					
Phosphorous, Z =15					

VALENCE OF METALS AND NON METALS.

Group	I	II	III	IV	V	VI	VII	VIII
Valency	1+	2+	3+	4-	3-	2-	1-	0

Discussion Question 12.8(c)

In groups or individually, copy and complete the table below to show the valences of each ion in each group, if any using the table in (b) aobve. Share and compare your findingd with the other group members in the class.

Group	I	II	III	IV	V	VI	VII	VIII
Period 1	H							He
2	Li	Be	B	C	N	O	F	Ne
3	Na	Mg	Al	Si	P	S	Cl	Ar
4	K	Ca						

Sample of Activity of Integration

Scenario:

Chemistry is one of the practical compulsory science subjects studied at both secondary and University levels in Uganda. A certain school in Dokolo District went for a study tour at Soroti Flying school of Aero-space in the Eastern part of Uganda. The aero-space site engineer, Miss Nakato Bridget welcomed the students and later took them through a session of learning process, she mentioned and explained to them some of the metals used in the construction of Aero-plane, the role of these metals plays in building the body of aero-plane.

Your school is organizing academic day where all parents of S.2 class will be invited on that day. Your Head teacher, wants the parents and the rest of the entire schools to appreciate the importance of some commonly known metals used in our day – to – day life activities

Task:

The Head of Chemistry Department, selected you to prepare a speech to the parents and the rest of the students in your school, guiding them the:

a) Importance of learning about the Periodic Table of elements.
b) Importance of the physical properties of metals and non – metals and relating them to their day – to – day uses. Use the examples of metals and non-metals provided.

12.8. End of Chapter 3 Summary:

In this chapter, you have leant that:

- Periodic Table contains 103 known elements. They are some which are metals and others are non – metals. Metals lose electrons to become **cations** and non – metals gain electrons to become **anions**.
- **A period** is a horizontal row containing elements of different groups. There are 7 periods of elements. Period shows the number of energy levels of an element.
- **A group** is a vertical column of the same elements with the same physical properties and valence electrons. There are 8 groups in the Modern periodic table. Group shows the number of the electrons in the outer most shell.
- Protons, electrons and neutrons are the subatomic (fundamental) particles of an atom of an element. **Protons** are positive charged particles located inside the nucleus of an atom. **Electrons** are negative particles located outside the nucleus of an atom. **Neutrons** are neutral particles located inside the nucleus of an atom. The proton and electron numbers are always the same, whereas the proton and neutron numbers are not always the same.
- **Atomic number** (**Z**) is the number of protons inside the nucleus of an atom.
- **Mass number (A)** is the total number of protons and neutrons inside the nucleus of an atom.
- **Isotopy** is the existence of an element in more than one forms of atoms. **Isotope** is a group of atoms of an element with the same **atomic number** but different **mass numbe**r. Or Isotope is a group of atoms of an element with the same **proton number** but different **neutron number**.
- **Metals** are placed at the extreme left-end side and non – metals at the extreme right – end of the Periodic Table.

End of Chapter 12 Exam – style Questions

1) Aluminium is an element of the Periodic Table. Its symbol is $^{27}_{13}\boldsymbol{Al}$.
a) State what the numbers above, represent
b) Number 27 (ii) Number 13.
c) Calculate the number of neutrons of Aluminium atom.
d) Write the electronic configurations of:
(i) Aluminium atom, *Al* (ii) Aluminium ions, $\boldsymbol{Al^{3+}}$
e) Write the formula of the:
(i) Oxide of Aluminium (ii) Chloride of Aluminium.
2) State whether the following statements provided are **true** or **false**.
a) Metals become cations by gain of electrons ……
b) Metals are located at the extreme left -end of the Periodic Table……...
c) Non – metal become anions by gain of electrons……
d) Cations are formed when metals lose their outer-most valence electrons……...
e) All metals don't conduct heat nor electricity except non – metals…….
f) All metals in group I elements are very reactive metals than those of group II…….
g) All group II metals lose two electrons except group I metals to form cations……
3) The following are atoms of some elements. They are represented as $^{24}_{12}\mathbf{X}$; $^{24}_{12}\mathbf{W}$ and $^{24}_{12}\mathbf{Y}$. Use them to answer the questions that follow:
a) State the proton, electron and neutron numbers of each atom of the element. Use the table below.

Atom	Proton number	Neutron number	Electron number
X			
W			
Y			

b) What name is given to these atoms of an element? Give a reason for your answer.

c) Define the term **"isotope"**

4) Atoms of some elements are given, A, B, C and D with their atomic numbers 12, 17, 8 and 7 respectively.

a) Write the electronic configuration of each atom of elements.

b) Identify the atoms of the elements which are:

(i) Metals:

(ii) Non – metals.

c) Write the formulae of the ions of each atom of the elements.

5) Define the following terms:

a) Protons (b) An ion (c) Electrons (d) Atomic number (e) Neutrons (f) Mass number.

Dr. Kenneth Opio